Phase Measurement System for Gravitational Wave Detection

Completed Technology Project (2017 - 2018)

Project Introduction

We propose to advance the maturity of the LISA Phasemeter based on our recent experience developing a flight Phasemeter for the Laser Ranging Interferometer (LRI) on NASA's GRACE Follow-On mission. Our three main objectives are to: 1) incorporate the flight GRACE Follow-on LRI phasemeter developments into the TRL4 LISA design used extensively in our interferometer testbed [12]; 2) evaluate the LRI Phasemeter against LISA's more stringent requirements in order to identify required design changes; 3) advance the design maturity of the LISA phasemeter through an architecture study to maintain the viability of the Phasemeter as a contribution to ESA's L3 gravitational wave mission. NASA intends to partner in the European Space Agency's (ESA) Gravitational-Wave detection mission, selected for the L3 mission to launch in 2034. This is expected to be a LISA-like mission [1, 2, 3] with the two enabling LISA technologies: 1. a drag-free system to mitigate or measure non-gravitational forces on the spacecraft, 2. an interferometric measure¬ment system with precision phasemeters [4] to measure picometer variations over the million kilometer separation between the spacecraft. To validate the key technologies of the drag-free system, the ESA LISA Pathfinder (LPF) mission [5] is currently demonstrating a gravitational reference sensor (GRS) and micro-Newton thrusters in space. While LPF has an on-board interferometer to measure proof-mass motion with respect to the spacecraft, the LPF interferometer does not test the inter-spacecraft laser interferometry needed for a LISA-like mission. To validate the key technologies of the LISA interferometric measurement, the JPL LISA Phase Measurement Team has studied and developed a prototype LISA phase measurement system. This phase measurement system has also been adapted for a demonstration mission, albeit in a different arena. GRACE Follow-On's Laser Ranging Interferometer (LRI) [6], due to launch in late 2017, will make LISA-like inter-spacecraft interferometric measurements across the ~200 km separation between spacecraft. The LRI interferometric measurement system has a LISA-like precision phasemeter as the main science instrument, with similar signal environments but relaxed or reduced requirements. The proposers first developed the prototype LISA phasemeter that made the LRI possible, and then developed and delivered the flight LRI phasemeter.

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Strategic Astrophysics Technology

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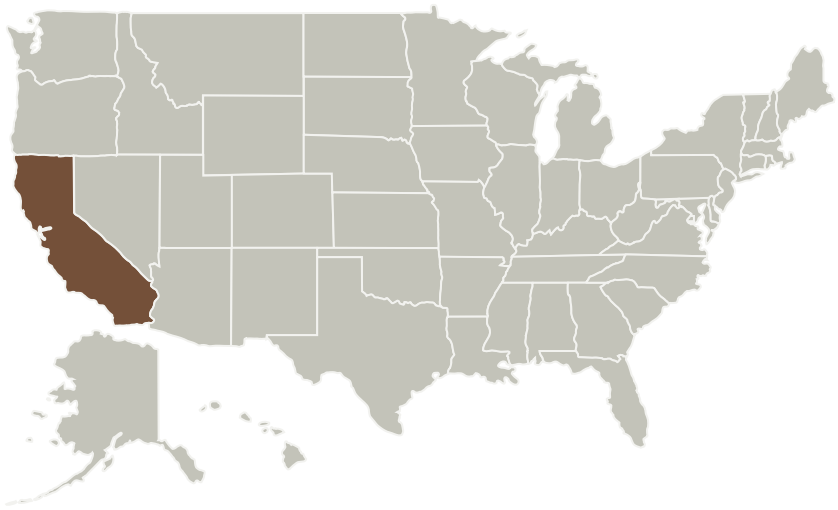
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
California Institute of Technology(CalTech)	Supporting Organization	Academia	Pasadena, California

Primary U.S. Work Locations
California

Project Management

Program Director:
Mario R Perez

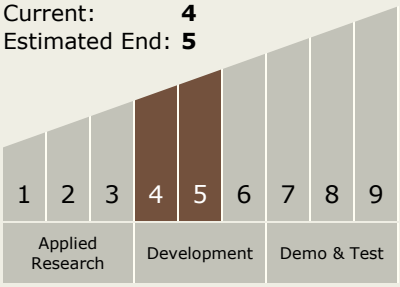
Program Manager:
Mario R Perez

Principal Investigator:
William Klipstein

Co-Investigators:
Brent Ware
Carlos J Velazquez
Jeff Dickson
Kirk Mckenzie
Robert Spero

Technology Maturity (TRL)

Start: **4**
Current: **4**
Estimated End: **5**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.3 In-Situ Instruments and Sensors
    - TX08.3.1 Field and Particle Detectors

Target Destination

Outside the Solar System